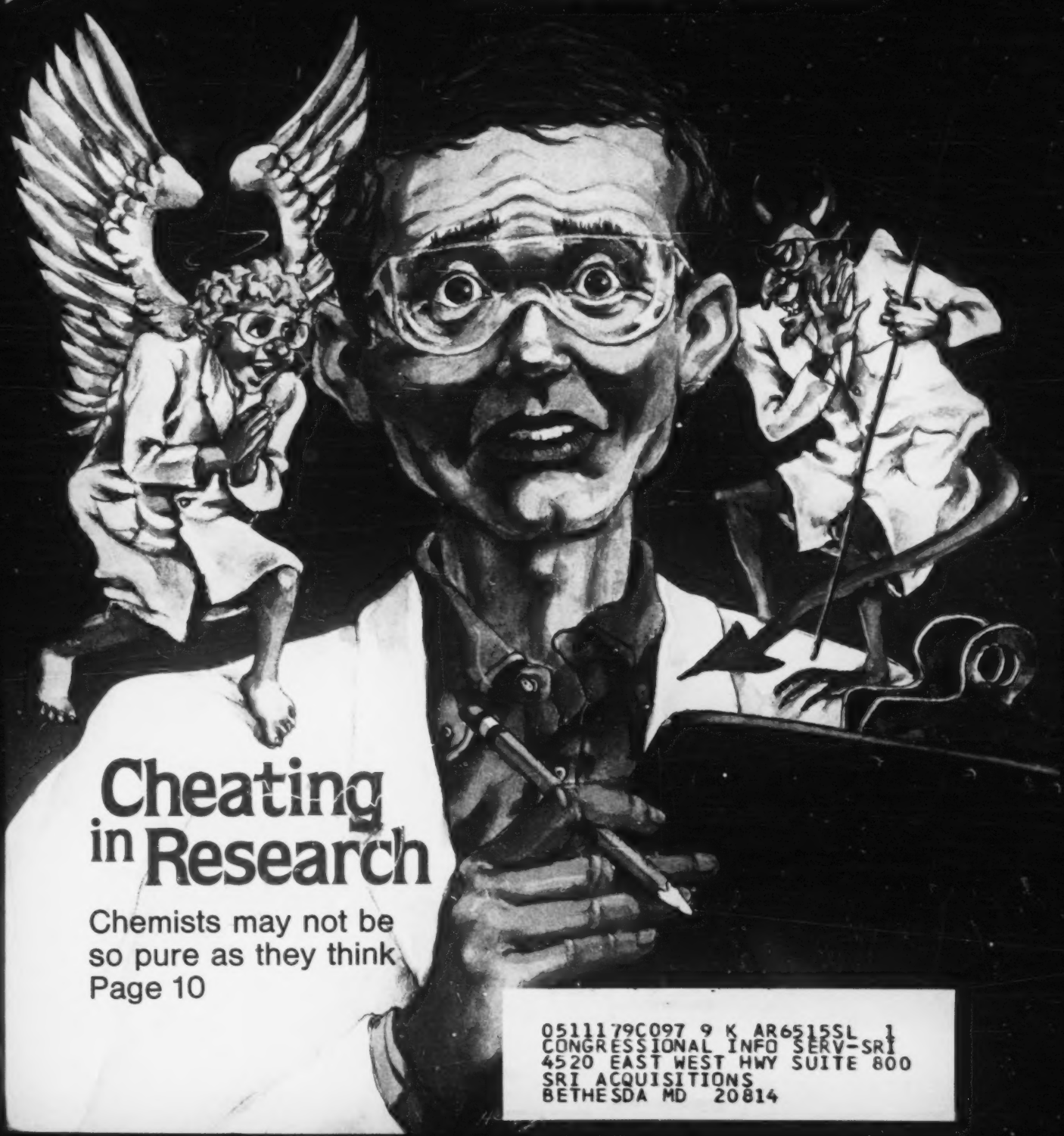
A1250-1
4/15/87

Top 50 chemical products
Page 20

APRIL 13, 1987
CHEMICAL & ENGINEERING
NEWS



Cheating in Research

Chemists may not be so pure as they think
Page 10

05111790097 9 K AR6515SL 1
CONGRESSIONAL INFO SERV-SRI
4520 EAST WEST HWY SUITE 800
SRI ACQUISITIONS
BETHESDA MD 20814

CHEMICAL & ENGINEERING
NEWS
Volume 65, Number 15
CENEAR 65(15) 1–52
ISSN 0009-2347
APRIL 13, 1987

News of the Week

■ **Superconductivity tutorial at ACS meeting in Denver focuses on the role of chemists in the fast-moving field.** **Page 4**

■ **ACS Council, meeting in Denver, raises membership dues $3.00, nominates two candidates for 1988 president-elect among other council business.** **Page 5**

■ **A drug search was conducted at Du Pont's Towanda, Pa., photographic products plant following discovery of drugs at work site.** **Page 6**

■ **Association of American Universities members to take a vote on antilobbying resolution.** **Page 6**

■ **Interleukin-2, used in cancer therapy, can activate the patient's immune system to destroy cancer cells, studies data indicate.** **Page 7**

■ **President Reagan agrees to consider acid rain accord at U.S.-Canada summit meeting.** **Page 8**

■ **U.K. chemicals capital spending to rise 3% in 1987, according to U.K. trade group survey.** **Page 8**

Business

Production of chemicals in C&EN's Top 50 group stabilized in 1986, partly as a result of improved housing and automotive markets. **Page 20**

Output of polymers—plastics, synthetic fibers, and synthetic rubber—climbed again in 1986, reaching a record 52.2 billion lb. **Page 23**

Growing foreign debts of developing countries are adversely affecting U.S. chemical trade. **Page 25**

Monsanto begins semicommercial production of new phosphate fiber, a substitute for short fiber asbestos. **Page 26**

Government

Lobbying methods used by many universities to obtain federal funding for laboratory construction continue to stir controversy. **Page 28**

Chemical plant pilot inspection program conducted by OSHA is given mixed review by that agency. **Page 29**

Science

IUPAC will label periodic table with Arabic numbers 1–18 in its next guidebook, scheduled for early 1988 publication. **Page 31**

U.K. introduces on-line microorganism database that will offer access to information on more than 30,000 microbial strains. **Page 33**

Books

"False Prophets: Fraud and Error in Science and Medicine" offers a lively account of cases of misconduct but few remedies. **Page 34**

Letters 2
Editor's Page 3

Concentrates
Business 18
Government 27
Science 30

The Departments
Meetings 36
Newscripts 52

News Focus

Chemists view fraud in chemical research as a rare occurrence, much less common than in other disciplines; however, misconduct may be more prevalent than they think. **Page 10**

Top 50 Chemicals Production Steadied in 1986

Output slipped slightly as organic chemicals rebounded to increase 9.2%; inorganic chemicals, however, continued their poor showing

Marc S. Reisch, C&EN New York

An improved housing market and a good year for auto production helped stabilize total U.S. chemicals output in 1986. Production was down a marginal 0.6% in 1986 compared with last year as indicated by C&EN's Top 50 chemicals group. This marked an improvement over 1985 when total U.S. production dropped 2% compared with the previous year.

The partial recovery due to improvements in housing and auto markets was dampened by the continuing slump in the U.S. farm economy. Also having a negative impact were imports of chemicals, which remained at historic high levels throughout 1986. However, U.S. exports of chemicals increased in 1986 with some help from a decline in the value of the U.S. dollar, which made chemicals cheaper for some foreign buyers.

Rebounding from 1985's poor showing, the organic chemicals component of the Top 50 showed the greatest improvement. Production of those substances increased 9.2% compared with 1985. That was a decided improvement over 1985's production decrease of 1.9% compared with the previous year.

However, like the year before, 1986 was a poor one for inorganic chemicals nearly across the board. Output of the major fertilizer chemicals, including phosphoric acid, urea, and potash, continued to decline substantially. Other big-volume inorganics, such as nitric acid and ammonium nitrate, also showed large decreases. As a result, inorganic chemicals production declined 5.1% in 1986 compared with the previous year. Over the past five years,

About the Top 50 list of chemical products

Government data, trade association figures, and industry estimates all go into preparing C&EN's annual list of the Top 50 chemical products, ranked by production volume. The federal government is relied upon most heavily, but when government figures are not available other sources, primarily trade associations, are used. Industry sources and C&EN estimates are used only when other data are lacking.

Government data are not always accurate—they are only as good as the information that individual companies report. But they are an objective measure of production extending back many years. Therefore, relatively accurate indications of growth can be made on a consistent basis.

At this time of year, C&EN has access only to preliminary reports of production for 1986. When the government and trade associations issue their final reports, the outcome can be changed, sometimes dramatically. As a result, the production figures for earlier years that appear in the table on page 21 are different in some cases from those published in last year's Top 50 report. The final reports also can affect the rankings of chemicals. The 1985 rankings of 33 chemicals listed in the table, for example, are different from those in the similar table published by C&EN a year ago (C&EN, April 21, 1986, page 12).

The list itself covers production figures for the U.S. and includes chemicals produced for export. Candidates for the list include all basic, intermediate, and chemically homogeneous finished products. These range from chemical building blocks like ethylene and propylene to downstream products like vinyl acetate and ethylene glycol.

The roster also includes basic inorganic chemicals, but does not include what C&EN considers to be minerals, such as salt, gypsum, and sulfur. Lime is included because it is processed and has many chemical and industrial applications. Refractory (dead-burned) dolomite is excluded in the calculation of lime production.

In the organics list, such petrochemical feedstocks as ethane, butane, and propane are excluded arbitrarily because they are considered to be products of oil companies and because they have many nonchemical uses.

There are other gray areas besides lime and petrochemical feedstocks. For example, the basic aromatics—benzene, toluene, and xylene—are included. Admittedly, this makes the list less pure chemically.

Production figures are published by the government and trade associations in a variety of units—millions of pounds, thousands of tons, billions of cubic feet, millions of gallons, metric tons. To provide an accurate ranking and to make comparison of production volumes easier, C&EN not only gives production in common units but converts production to billions of pounds as well.

Top 50 chemicals production declined less than 1% last year

Rank			Billions of lb		Common units[b]		Average annual growth			
1986	1985[a]		1986	1985	1986	1985	1985–86	1984–85	1981–86	1976–86
1	1	Sulfuric acid	73.64	79.30	36,822 tt	39,651 tt	−7.1%	−5.1%	−2.0%	0.5%
2	2	Nitrogen	48.62	47.46	671 bcf	655 bcf	2.4	−0.9	6.5	8.8
3	4	Oxygen	33.03	32.53	399 bcf	393 bcf	1.5	2.1	−1.5	0.4
4	6	Ethylene	32.81	29.85	32,811 mp	29,847 mp	9.9	−4.9	2.2	3.9
5	5	Lime[c]	30.34	31.60	15,172 tt	15,800 tt	−4.0	−1.2	−4.3	−2.3
6	3	Ammonia	28.01	34.64	14,005 tt	17,319 tt	−19.1	3.8	−6.0	−1.8
7	7	Sodium hydroxide	22.01	21.79	11,007 tt	10,893 tt	1.0	−0.2	1.1	0.5
8	9	Chlorine	20.98	20.79	10,489 tt	10,395 tt	0.9	−2.8	−0.5	0.1
9	8	Phosphoric acid	18.41	21.04	9,206 tt	10,518 tt	−12.5	−7.5	−1.6	1.5
10	11	Propylene	17.34	14.89	17,343 mp	14,887 mp	16.5	−4.3	5.2	5.6
11	10	Sodium carbonate[d]	17.20	17.19	8,600 tt	8,597 tt	0.0	1.0	0.8	5.1
12	15	Ethylene dichloride	14.53	12.10	14,529 mp	12,101 mp	20.1	13.0	7.8	6.1
13	12	Nitric acid	13.12	14.73	6,562 tt	7,364 tt	−10.9	−4.7	−6.3	−1.7
14	14	Urea[e]	12.06	13.36	6,029 tt	6,678 tt	−9.7	−10.2	−5.6	4.4
15	13	Ammonium nitrate[f]	11.11	13.55	5,556 tt	6,776 tt	−18.0	−5.2	−8.9	−2.5
16	17	Benzene	10.23	9.39	1,389 mg	1,275 mg	8.9	−3.3	1.2	−0.3
17	20	Ethylbenzene	8.92	7.39	8,915 mp	7,386 mp	20.7	−2.3	2.7	4.4
18	18	Carbon dioxide[g]	8.50	9.25	4,252 tt	4,623 tt	−8.0	1.3	2.3	8.0
19	16	Vinyl chloride	8.42	9.46	8,415 mp	9,463 mp	−11.1	55.5	4.1	4.0
20	19	Styrene	7.84	7.62	7,838 mp	7,622 mp	2.8	−1.1	3.3	2.2
21	21	Terephthalic acid[h]	7.68	6.49	7,684 mp	6,490 mp	18.4	9.8	4.3	0.6
22	27	Methanol	7.33	5.00	7,327 mp	5,003 mp	46.5	−38.9	−3.1	1.6
23	22	Hydrochloric acid	5.97	5.61	2,983 tt	2,807 tt	6.3	2.7	3.0	1.6
24	24	Ethylene oxide	5.94	5.43	5,943 mp	5,430 mp	9.4	−4.7	2.9	3.6
25	22	Formaldehyde[i]	5.89	5.61	5,885 mp	5,606 mp	5.0	−3.6	0.6	0.8
26	26	Toluene[j]	5.82	5.07	802 mg	699 mg	14.7	−4.0	−1.2	−2.2
27	25	Xylene	5.55	5.31	771 mg	738 mg	4.5	−13.6	−2.6	0.7
28	30	Ethylene glycol	4.76	4.18	4,759 mp	4,178 mp	13.9	−13.4	2.8	3.6
29	28	*p*-Xylene	4.67	4.78	4,669 mp	4,779 mp	−2.3	12.1	0.6	4.8
30	29	Ammonium sulfate	4.17	4.19	2,086 tt	2,093 tt	−0.3	1.3	−0.9	0.4
31	31	Cumene	3.70	3.35	3,695 mp	3,345 mp	10.5	−10.9	2.2	3.1
32	32	Acetic acid	2.93	2.90	2,931 mp	2,897 mp	1.2	10.6	−0.9	1.8
33	34	Phenol[k]	2.92	2.78	2,921 mp	2,777 mp	5.2	−3.9	2.5	3.3
34	39	Butadiene[l]	2.59	2.34	2,593 mp	2,340 mp	10.8	−4.6	−2.8	−3.0
34	35	Carbon black	2.59	2.57	2,585 mp	2,571 mp	0.5	−11.1	−1.1	−1.6
36	33	Potash[m]	2.58	2.84	1,169 tmt	1,288 tmt	−9.2	−17.6	−11.5	−6.0
37	36	Aluminum sulfate	2.52	2.54	1,258 tt	1,268 tt	−0.8	12.3	−0.6	0.5
38	37	Propylene oxide	2.48	2.40	2,480 mp	2,400 mp	3.3	34.9	6.1	3.1
39	38	Acrylonitrile	2.31	2.35	2,314 mp	2,346 mp	−1.4	5.7	3.0	4.3
40	40	Vinyl acetate	2.25	2.11	2,249 mp	2,112 mp	6.5	4.3	3.0	4.3
41	41	Methyl *tert*-butyl ether[n]	2.24	1.89	2,237 mp	1,891 mp	18.3	37.4	24.1	nm
42	44	Cyclohexane	2.07	1.66	2,071 mp	1,657 mp	25.0	−16.9	2.6	−0.5
43	42	Acetone	1.94	1.79	1,936 mp	1,788 mp	8.3	−4.0	−2.0	0.4
44	43	Titanium dioxide	1.83	1.72	917 tt	860 tt	6.6	3.0	3.8	2.5
45	48	Sodium silicate	1.57	1.44	786 tt	721 tt	9.0	−3.9	0.4	0.5
46	46	Calcium chloride[o]	1.56	1.88	780 tt	940 tt	−17.0	−10.4	−3.2	−4.2
47	45	Sodium sulfate[p]	1.55	1.65	775 tt	827 tt	−6.3	−5.2	−6.9	−4.5
48	47	Adipic acid	1.52	1.45	1,522 mp	1,453 mp	4.7	4.5	2.0	0.0
49	50	Isopropyl alcohol	1.28	1.24	1,275 mp	1,235 mp	3.2	−11.4	−5.2	−4.1
50	49	Sodium tripolyphosphate	1.27	1.25	634 tt	625 tt	1.4	−7.4	−1.8	−1.3
TOTAL ORGANICS			188.00	172.16			9.2%	−1.9%	1.8%	2.9%
TOTAL INORGANICS			350.60	369.56			−5.1%	−2.0%	−1.5%	0.8%
GRAND TOTAL			538.60	541.72			−0.6%	−2.0%	−0.5%	1.5%

a Revised. b tt = thousands of tons, bcf = billions of cubic feet, mp = millions of pounds, mg = millions of gallons, tmt = thousands of metric tons. c Except refractory dolomite. d Natural and synthetic. e 100% basis. f Original solution. g Liquid and solid only. h Includes both acid and ester without double counting. i 37% by weight. j All grades. k Synthetic only. l Rubber grade. m K_2O basis. n Production data for earlier years unavailable. o Solid and liquid. p High and low purity. nm = not meaningful.

inorganics production has fallen at an average annual rate of 1.5%.

Half of the Top 50 chemicals registered an increase in production for 1986. By contrast, only 18 showed increased production in 1985. Total production was down 6.3% to 539 billion lb compared with the industry's historical high of 575 billion lb reached in 1979. The 1986 production level is 16.2% higher than the decade-low production level of 464 billion lb registered in 1982.

For the entire Top 50 group, composite output declined at a compound annual rate of 0.5% between 1981 and 1986. However, indicative of long-term growth, Top 50 production grew at an average annual rate of 1.5%.

The greatest individual growth in terms of production last year came mostly on the organics side. Methanol registered the largest production increase in 1986, up 46.5% to 7.33 billion lb. The gain pushed the chemical up to 22nd place on the Top 50 list from 27th place in 1985. The increase is all the more remarkable inasmuch as methanol showed the single largest output decline of any chemical on the Top 50 list in 1985, when production was down 38.9% compared with the previous year.

Next in terms of percentage gains among the organics in 1986 was cyclohexane, with output up 25% to 2.07 billion lb; ethylbenzene, up 20.7% to 8.92 billion lb following a decline of 2.3% in 1985; and ethylene dichloride, up 20.1% to 14.53 billion lb.

On the negative side, the biggest decrease on the organics side in 1986 came from vinyl chloride, whose production fell 11.1% compared with the previous year, and urea, down 9.7%.

Although the inorganics component in 1986 showed the greatest declines from production levels in the year-earlier period, some chemicals did register relatively strong increases. Sodium silicate production grew 9% in 1986 to 1.57 billion lb compared with the previous year. More modest rates of increase were recorded by titanium dioxide, up 6.6% in 1986 compared with the year earlier to 1.83 billion lb; and hydrochloric acid, up 6.3% to 5.97 billion lb.

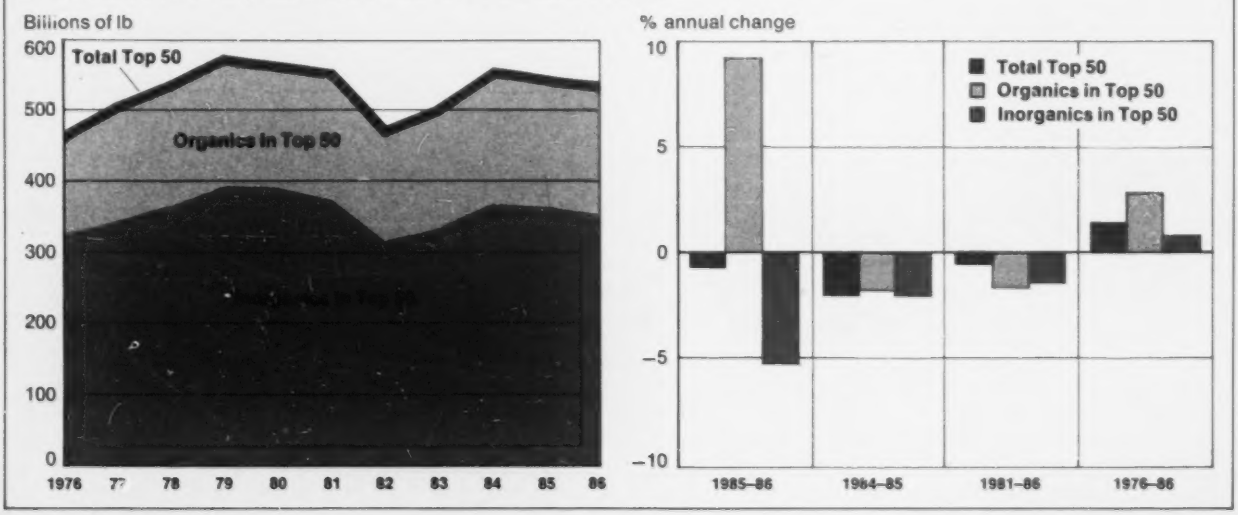
Slow growth or no growth, however, seemed to be more often the rule among the inorganic chemicals on the Top 50. Ammonia registered the largest decline in 1986, with production down 19.1% to 28.01 billion lb and dropping it to sixth place in the rankings of the Top 50 from third place in 1985. Also showing a considerable production decline was ammonium nitrate, down 18% from the previous year to 11.11 billion lb; followed by phosphoric acid, down 12.5% to 18.41 billion lb; and potash, down 9.2% to 2.58 billion lb.

Revised figures for propylene oxide for 1985 and 1986 as a result of more reliable information from industry sources have required drastic changes in this chemical's production. As a result, the average annual growth for the chemical between 1984 and 1985 at 34.9% in this year's C&EN listing is probably overstated. C&EN believes that the 3.3% growth reported for propylene oxide between 1985 and 1986 is a reliable indicator of the trend in this chemical's production.

Over the past five years, 27 of the Top 50 chemicals have registered increases in their growth rates. Leading in individual growth rates over the five-year span was methyl *tert*-butyl ether, whose production grew at an annual compound rate of 24.1%. Following this chemical in growth rate were ethylene dichloride, up 7.8% annually for the five-year period; nitrogen, up an average 6.5% a year; propylene oxide, up an average 6.1% a year; terephthalic acid, up an average 4.3% a year; and vinyl chloride, up an average 4.1% a year.

Leading the products with the largest individual decreases in production over the five-year period was potash, whose output fell at a compound annual rate of 11.5%. Other chemicals registering hefty decreases over the five-year period were ammonium nitrate, down 8.9% a year on average; sodium sulfate, down 6.9% a year on average; urea, down 5.6% year on average; and

Basic chemicals production continues to decline



isopropyl alcohol, down 5.2% a year on average.

Over the past 10 years, 34 of the Top 50 chemicals have recorded production increases. The best long-term performer has been nitrogen, whose output has grown at an annual compound rate of 8.8% during this period. Production of carbon dioxide also grew at a remarkable rate of 8%. Other chemicals with sizable annual compound growth rates were ethylene dichloride, up 6.1% between 1976 and 1986, and sodium carbonate, up 5.1%.

Potash has registered the greatest average annual rate of decline over the past 10 years. Its output has fallen at a compound rate of 6%. Other products with shrinking output were sodium sulfate, down 4.5% a year on average; isopropyl alcohol, down 4.1% a year on average; calcium chloride, down 4.2% a year on average; and butadiene, down 3% a year on average.

The group comprising the 10 largest chemical commodities in terms of production was nearly the same. The one exception was sodium carbonate, which had ranked 10th on the 1985 list. It moved down a notch to become the 11th-ranked chemical on the 1986 list, switching places with propylene, the 11th-ranked chemical product in 1985.

There was a good deal of rank shifting through the rest of the list. In all, 33 of the chemicals on the list either moved up or down in the rankings.

Besides the rise already noted for propylene and the fall for sodium carbonate, other significant changes in rank included ethylene dichloride, which, with its 20.1% increase in production in 1986 compared with the year earlier, jumped to 12th place from 15th in 1985; and ethylbenzene, which jumped to 17th place from 20th place in 1985. □

Polymer output records fourth consecutive annual rise

Overall production of plastics, synthetic fibers, and synthetic rubber polymers reached a record high of 52.2 billion lb in 1986. The growth marked the fourth consecutive annual increase for the product group, lifting the output total 5.9% above the 1985 record and exceeding 50 billion lb for the first time.

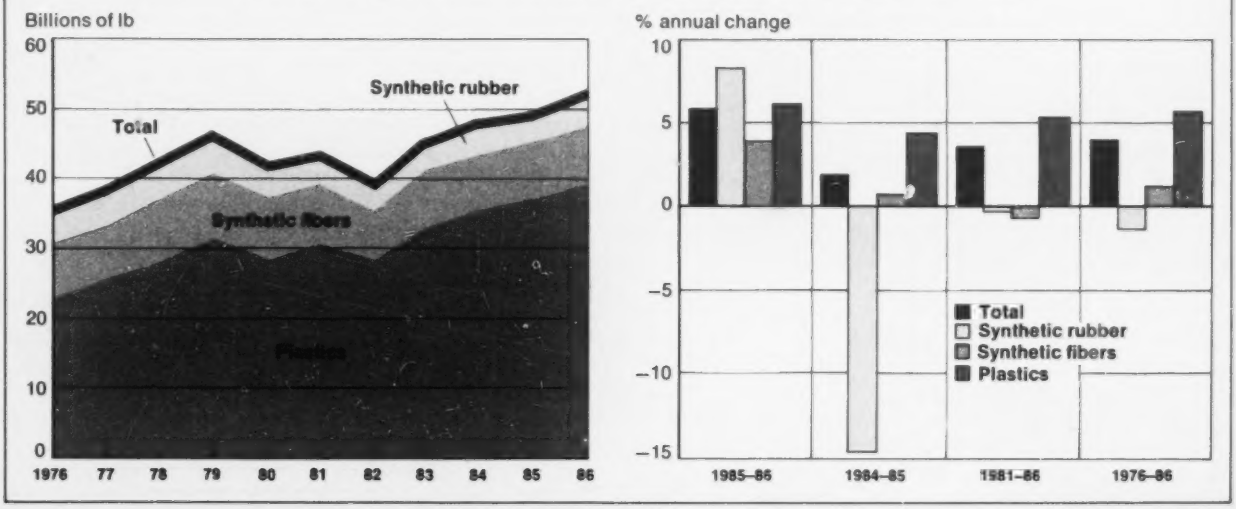
Synthetic rubber displayed a spectacular recovery in 1986 as total output increased 8.1% after registering a significant decrease of 14.7% in 1985 from the year-earlier level. Production of styrene-butadiene registered a 7.8% annual growth rate last year following an enormous 23.3% drop in 1985 compared with the year earlier. Other synthetic rubber products showing significant production increases were nitrile, up 9.4% in 1986 after declining 20.9% in 1985 compared with the previous year; and ethylene-propylene, which resumed its upward growth at a healthy 7% in 1986 after registering no growth in the previous year. Also recording a strong growth of 15.2% last year were the synthetic rubber products reported as a group by the Rubber Manufacturers Association: neoprene; butyl; polyisoprene; chlorosulfonated polyethylene; polyisobutylene; and acrylo, fluoro, polysulfide, and silicone elastomers.

Only polybutadiene failed to reestablish a growth pattern in 1986, with production down 10 million lb from the year-earlier level. Polybutadiene registered a 1.5% decline from 1985, and an 8.1% decline compared with 1984.

However, the long-term picture for the synthetic rubbers group is not nearly so rosy as its 1986 production numbers alone might indicate. Over the past five years, this polymer segment's output has declined at an average annual rate of 0.3%, and 1.5% over the past 10 years.

Plastics account for more than two thirds of the polymer group production total. In 1986 this segment

Output increased for plastics, synthetic fibers, and synthetic rubber in 1986



Total polymers production exceeded 50 billion lb last year

	Billions of lb		Common units					Average annual growth			
	1986	1985	1986	1985	1984	1981	1976	1985–86	1984–85	1981–86	1976–86
PLASTICS (millions of lb)											
Thermosetting resins	**5.83**	**5.63**	**5,834**	**5,631**	**5,549**	**5,010**	**3,633**	**3.6%**	**1.5%**	**3.1%**	**4.9%**
Phenol, other tar acid resins	2.72	2.62	2,721	2,621	2,502	2,333	1,340	3.8	4.8	3.1	7.3
Urea resins	1.27	1.21	1,271	1,210	1,199	1,165	821	5.0	0.9	1.8	4.5
Polyesters (unsaturated)	1.27	1.22	1,271	1,223	1,232	997	1,042	3.9	−0.7	5.0	2.0
Epoxies (unmodified)	0.40	0.39	398	385	406	336	244	3.4	−5.2	3.4	5.0
Melamine resins	0.17	0.19	173	192	210	179	186	−9.9	−8.6	−0.7	−0.7
Thermoplastic resins	**33.57**	**31.53**	**33,569**	**31,525**	**30,036**	**25,671**	**19,481**	**6.5%**	**5.0%**	**5.5%**	**5.6%**
Low-density polyethylene	8.89	8.89	8,888	8,889	8,413	7,693	5,813	0.0	5.7	2.9	4.3
PVC and copolymers	7.26	6.77	7,256	6,772	6,760	5,707	4,716	7.1	0.2	4.9	4.4
High-density polyethylene	7.17	6.67	7,171	6,671	6,085	4,695	3,125	7.5	9.6	8.8	8.7
Polystyrene[a]	4.44	4.05	4,442	4,054	3,838	3,621	3,195	9.6	5.6	4.2	3.4
Polypropylene	5.81	5.14	5,812	5,139	4,940	3,955	2,632	13.1	4.0	8.0	8.2
TOTAL[b]	**39.40**	**37.16**	**39,403**	**37,156**	**35,585**	**30,681**	**23,114**	**6.0%**	**4.4%**	**5.1%**	**5.5%**
SYNTHETIC FIBERS (millions of lb)											
Cellulosics	**0.62**	**0.56**	**619**	**558**	**589**	**770**	**791**	**10.9%**	**−5.3%**	**−4.3%**	**−2.4%**
Rayon	0.40	0.35	404	353	390	509	493	14.4	−9.5	−4.5	−2.0
Acetate[c]	0.22	0.21	215	205	199	261	298	4.9	3.0	−3.8	−3.2
Noncellulosics[b]	**7.82**	**7.56**	**7,815**	**7,564**	**7,473**	**7,982**	**6,615**	**3.3%**	**1.2%**	**−0.4%**	**1.7%**
Polyester	3.30	3.34	3,304	3,341	3,392	4,173	3,341	−1.1	−1.5	−4.6	−0.1
Nylon[d]	2.52	2.34	2,515	2,343	2,412	2,333	2,076	7.3	−2.9	1.5	1.9
Olefin[e]	1.38	1.25	1,380	1,249	998	785	577	10.5	25.2	11.9	9.1
Acrylic[f]	0.62	0.63	616	631	671	691	621	−2.4	−6.0	−2.3	−0.1
TOTAL[b]	**8.43**	**8.12**	**8,434**	**8,122**	**8,062**	**8,752**	**7,406**	**3.8%**	**0.7%**	**−0.7%**	**1.3%**
SYNTHETIC RUBBER (thousands of metric tons)											
Styrene-butadiene[g]	1.75	1.62	792	735	958	1,032	1,333	7.8	−23.3	−5.2	−5.1
Polybutadiene	0.72	0.73	325	330	359	342	352	−1.5	−8.1	−1.0	−0.8
Ethylene-propylene	0.51	0.47	230	215	215	178	130	7.0	0.0	5.3	5.9
Nitrile	0.13	0.12	58	53	67	66	73	9.4	−20.9	−2.6	−2.3
Other[h]	1.28	1.11	582	505	556	404	416	15.2	−9.2	7.6	3.4
TOTAL[b]	**4.38**	**4.05**	**1,987**	**1,838**	**2,155**	**2,022**	**2,304**	**8.1%**	**−14.7%**	**−0.3%**	**−1.5%**

a No longer includes acrylonitrile-butadiene-styrene or styrene-acrylonitrile resins; historical data are restated. b Totals are for those products listed. Totals may not add because of rounding. c Includes diacetate and triacetate yarn, but does not include cigarette tow. Beginning with 1985, includes rayon yarn. d Excludes aramid after 1982. e Includes olefin film, olefin fiber, spun-bonded polypropylene, and vinyon. f Includes modacrylic. g Excludes high-styrene latex. h Beginning with 1985, includes neoprene; historical data are restated. Also includes butyl; polyisoprene; chlorosulfonated polyethylene; polyisobutylene; and acrylo, fluoro, and silicone elastomers. **Sources:** Society of the Plastics Industry, Textile Economics Bureau, Rubber Manufacturers Association

continued its buoyant growth rate, with production up 6% from the year earlier. The strongest growth was registered by the thermoplastics side of the segment, with polypropylene recording the highest growth, 13.1%, followed by polystyrene, 9.6%, and high-density polyethylene, 7.5%. Overall thermoplastics production rose 6.5%.

By comparison, output of thermosetting resins grew 3.6% in 1986. Urea resins showed the best growth of all members of the group, with production up 5% compared with 1985. Polyester resins also sustained a good growth rate of 3.9% and phenol and other tar acid resins grew 3.8%. Only melamine resins, down 9.9%, continued their downward spiral after an earlier production decline in 1985.

For the 10-year period between 1976 and 1986, the plastics segment grew at an annual compound rate of 5.5%. For the five years between 1981 and 1986, plastics grew at an annual compound rate of 5.1%.

Though the slowest growing of the entire polymers products group, synthetic fibers nevertheless recorded a production increase of 3.8% in 1986 over the year-earlier level. Despite continued pressure from imported textiles, both cellulosic and noncellulosic fibers registered gains.

Output of cellulosic fibers, the smallest segment of the fibers group, showed the strongest recovery, rising 10.9% in 1986. Rayon and acetate were in greater demand for fashion apparel in the past year, helping the recovery.

The noncellulosics group, which accounted for more than 90% of fiber production last year, recorded a 3.3% increase in output last year. Olefins continued to lead the way in year-to-year production increases, up 10.5% in 1986. Nylon also showed substantial growth in 1986, up 7.3% owing in part to heavy demand for carpet fibers.

Other members of the noncellulosics group did not fare so well. Heavy demand for acrylic sweater yarns still did not translate into higher acrylic production in 1986. Acrylic fiber output fell 2.4% in 1986. And polyester production also declined in 1986. Production of this fiber slipped 1.1% as polyester makers shut down textile filament production because of lagging demand. □

U.S. chemical trade hurt by developing country debt

The foreign debts of many developing countries seem to be a problem that just won't go away. The total foreign debt of just the five largest developing country debtors (Brazil, Mexico, Argentina, Venezuela, and the Philippines) now tops $330 billion. Rather than declining, this debt burden is increasing.

In the developing countries themselves, these staggering debts are raising havoc with domestic economies and their social, labor, and political structure. But the impact also is being felt in the U.S., and that impact extends far beyond the bottom lines of the banks that lent these countries the money in the first place.

As these countries adopt economic policies to cope with their debt, the trade, even the output, of many U.S. manufacturing industries has suffered. Among the hardest hit is the chemicals and allied products industry. The reason: To build foreign exchange for repaying their debts, these countries typically curb their imports and do everything they can to push exports. As a result, U.S. industries that rely on developing countries as major markets for their products feel the pinch.

The U.S. chemical industry is one of those industries. In 1980, more than $9 billion, or about 44% of U.S. chemical exports, went to developing countries. That is the year in which the U.S. chemical trade surplus (excess of exports over imports) hit a record $12.1 billion.

By 1985, the U.S. chemical trade surplus had slipped to $7.2 billion. Not surprisingly, exports to developing countries had shrunk to 36% of the total ($7.8 billion). Meanwhile, U.S. imports from these developing countries (the so-called Third World) grew from $942 million to $2.3 billion.

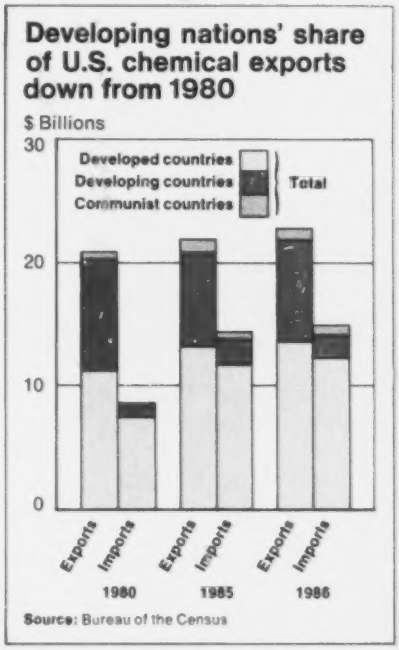
Last year, the U.S. chemical trade picture with the Third World improved somewhat. Chemical exports bounced back to $8.5 billion, but imports remained essentially flat at $2.4 billion. However, those exports still are only 37% of the U.S. chemical industry's total, far below the 1980 share.

A recent International Trade Commission (ITC) study indicates that, in 1985, the debt-related austerity measures adopted by the five largest Third World debtors hurt the trade balance in 40 of 61 nonservice U.S. industries. Hardest hit was the automotive and auto equipment industry. Right behind it was the chemical industry.

ITC estimates that, between 1980 and 1985, producers of "chemicals and selected products" lost almost $1.3 billion in their trade balance with these five countries. Throw in other products normally associated with the chemical industry, and the drop in the chemical trade surplus adds up to more than $1.6 billion. These products include plastics and synthetic materials, drugs, cleansers, toiletries, and paints and allied products.

The combination of lost exports and additional imports from these debtor countries has crimped U.S. chemical industry output. But the impact goes beyond the year-to-year drop in exports and the gain in imports. To ITC's way of thinking, a better measure is to compare actual 1985 trade data with what the situation might have been if both chemical exports and imports had retained a constant market share.

For its analysis, ITC selected the average market share in the 1979–81 period, which it refers to as the "predebt crisis" period. Thus, ITC assumes that, without a debt problem, each debtor developing nation's share of U.S. exports and imports would have been the same as it was before the debt crisis.



In its analysis of the five largest debtor countries, for instance, ITC estimates that net trade (exports less imports) for the chemicals and selected products segment of the industry would have been $1.6 billion in 1985 if exports and imports had retained their 1979–81 average market share. That's more than double 1985's actual net trade of $778 million.

U.S. chemical trade drops with debtor developing nations

$ Millions	Chemicals & selected products	Plastics & synthetic materials	Drugs, cleaning & toilet preparations	Paints & allied products	All products
1978	$ 1170	$ 349	$ 175	$13	$ −348
1979	1695	584	198	11	−119
1980	2050	723	235	15	3,220
1981	1681	687	251	19	2,242
1982	1232	571	226	24	−6,039
1983	753	454	173	20	−14,718
1984	987	388	201	24	−17,349
1985	778	407	165	25	−15,103
Net change 1980–85[a]	$−1272	$−316	$−70	$10	$−18,233

Note: U.S. net chemical trade (exports minus imports) with five debtor developing countries—Mexico, Brazil, Argentina, Venezuela, and the Philippines. a 1980 was chosen because it was the year in which the U.S. chemical trade surplus was the largest. Source: International Trade Commission

U.S. chemical output crimped by trade with debtor nations

$ Millions	Chemicals & selected products	Plastics & synthetic materials	Drugs, cleaning & toilet preparations	Paints & allied products
NET TRADE[a]				
Actual net trade, 1985	$778	$407	$165	$25
Net trade at constant market share[b]	$1661	$614	$271	$16
Difference	$−883	$−207	$−106	$9
Estimated change in industry output	$−1596	$−336	$−128	$−32
Estimated change as % of output	−1.97%	−0.91%	−0.23%	−0.34%
EXPORTS				
Ratio, 1985 exports to 1978–81 average	0.696	0.803	0.659	1.572
Actual exports, 1985	$1538	$512	$221	$25
Exports at constant market share[b]	$2212	$637	$335	$16
Difference	$−673	$−125	$−114	$9
Estimated change in industry output	$−1046	$−202	$−134	$−12
Estimated change as % of output	−1.29%	−0.55%	−0.24%	−0.12%
IMPORTS				
Ratio, 1985 imports to 1978–81 average	1.380	4.593	0.887	0.940
Actual imports, 1985	$761	$105	$56	neg
Imports at constant market share[b]	$551	$23	$64	neg
Difference	$210	$82	$−8	neg
Estimated change in industry output	$551	$133	$−5	$20
Estimated change as % of output	0.68%	0.36%	−0.01%	0.21%

Note: U.S. chemical trade with five debtor developing countries—Mexico, Brazil, Argentina, Venezuela, and the Philippines. a Exports minus imports. b What 1985 exports (or imports) would have been if they had retained their 1978–81 average market share. **neg** = negligible. **Source:** International Trade Commission

Based on such a comparison, ITC also estimates that the output of this segment of the industry was $1.6 billion lower than it would have been without a developing country debt crisis. That's an almost 2% drop in output, based on changing trade fortunes with only five developing countries.

Adding in the other segments of the chemical industry, such as plastics, drugs, and paints, brings the total estimated output loss in 1985 to more than $2 billion.

Between 1981 and 1985, while the debt burdens of many developing countries were growing to enormous proportions, the U.S. dollar was becoming stronger against most major currencies. Virtually all economists agree that the strengthening dollar was the leading cause of the poor U.S. export performance and the massive U.S. trade deficit.

In some cases, it is difficult to separate and identify the effects of country debt and the effects of the dollar on trade. Not so with the major debtors among the developing countries.

Just as it did against major trading currencies, the U.S. dollar also became stronger against the Mexican peso, the Brazilian cruzeiro (now the cruzado), and other currencies of debtor countries in the Third World. But the onus for the U.S. trade problems with these countries still rests squarely on the debt-related austerity policies initiated by these countries.

Stephen Cooney, director of international investment and finance at the National Association of Manufacturers, says there is a direct relationship between the rapid depreciation of many developing countries' currencies and the debt crisis. And, he adds, resolving these debt problems is crucial, not only to the economic health of these countries, but to improvement in U.S. export fortunes.

Despite the improvement in the U.S. chemical trade picture with Latin America last year, Cooney says that "we [the U.S.] are far from recovering our trade position in Latin America."

Earl Anderson, New York

Monsanto launches substitute for asbestos

Monsanto brought its first semi-commercial phosphate fiber plant on stream in St. Louis last month. With an annual capacity that Monsanto phosphate fiber program director Joseph J. Narciso sets at a few hundred tons, the plant takes the company a step toward recovering the investment it has made so far in its replacement for short fiber asbestos.

Monsanto's phosphate fiber is a patented synthetic, crystalline, polymeric fiber of calcium sodium metaphosphate. The fiber boasts very high temperature stability (to 470 °C) and also handles and processes very much like short asbestos fibers in gasket and friction materials, according to Narciso.

With this fiber development under way, Monsanto joins the host of manufacturers rushing in to provide adequate substitute materials in support of the Environmental Protection Agency's mandate to ban asbestos use where workable substitutes exist (C&EN, March 16, page 17).

The fiber's main selling point, says Narciso, is that it is not "bio-durable" and, unlike asbestos, isn't likely to pose significant health risks. Asbestos has been labeled a carcinogen because the tiny asbestos fibrils have a tendency to attach themselves to lung tissue.

Monsanto is near completion of a two-year inhalation study of its phosphate fiber in rats. Results so far substantiate the company's claim that the fiber is not bio-durable, Narciso says.

Development quantities of the fiber are now available at $2.00 per lb. Price is expected eventually to be between $1.00 and $2.00 per lb depending on market end use, Narciso says, putting the final price just above the cost of glass fiber but below the cost of aramid fiber, the two fibers Monsanto considers its principal competitors.

Monsanto's phosphate fiber has potential for use in brake linings, gaskets, thermal-resistant papers, caulks, and putties.

Marc Reisch, New York